Art. XXV.—*Physiography of the Mansfield District.*

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[Read 11th December, 1913.]

Contents.

I. Introduction. Area dealt with, etc.

II. Previous Literature.

III. Rivers and Creeks.
- (1) General Description.
- (2) Detailed Accounts.
  - (a) Blue Range Creek.
  - (b) Bridge Creek.
  - (c) Wild Dog and Back Creeks.
  - (d) Broken River.
  - (e) Ford's Creek.
  - (f) Delatite River.
  - (g) Goulburn River.

IV. Mountains and Hills.
- (1) General Description.
- (2) Detailed Accounts.
  - (a) Tolmie Highlands.
  - (b) "The Hilltops" and Gallows Hill.
  - (c) Mount Battery.
  - (d) Mount Terry and Springfield Hills.
  - (e) South Blue Range.
  - (f) Cave Hill.
  - (g) The Paps.
  - (h) The Darlingford Hills.
  - (i) Mount Buller.
  - (j) Mount Timbertop.

V. Other Features.
- (a) Barjarg Gap.
- (b) Power's Lookout.
- (c) Junction of Delatite and Goulburn Rivers.

VI. Progressive Physiography of the Upper Goulburn.

I.—Introduction.

The area dealt with in this paper may be roughly defined as that embraced in the central and eastern portions of the Shire of Mansfield. The parishes include—Nillahcootie, Dueran, Dueran East, Maindample, Barwite, Gonzaga, Mansfield, Beolite, Merrijig, Wappan, Loyola, Delatite, etc.

During 1913 I spent some months collecting data on the geology and physiography of the district, and this paper embodies the material collected under the latter head.

Physiographically, the Mansfield area is interesting, for at least three reasons :—

(a) It forms a part of the basin of the westward draining upper Goulburn River, the latter being an area of complex relief, and with many fine rivers.

(b) A variety of rock types, both igneous and sedimentary, occurs, and a corresponding variety of physiographic types is found.

(c) The sedimentary rocks are of various ages, with complex faulting, bringing further variety of physiographic features.

The upper Goulburn basin has moved several Victorian geographers to make speculations concerning it. It is distinctly impressive in Victorian mappings as the largest westerly draining valley in the State, and is easily noted, not only on contour maps, but on rainfall, population, and railway charts. The following detailed account of the Mansfield portion may help toward the elucidation of the bigger problems of the upper Goulburn.

II.—Previous Literature.

While there are no records of previous physiographic work in the Mansfield district, the following papers have been found very useful and suggestive :—

(a) Griffiths Taylor.—" Physiography of Eastern Australia," Com. Bureau Meteorology, Bull. No. 8, 1911.

(b) Jutson, J. T.—" Physiography of the Yarra River." Proc. Roy. Soc., Vic., Aug., 1908.

III.—Rivers and Creeks.

(1)—*General Description.*—(See fig. 1.)

In the north, Broken River, rising in the highlands that form the western boundary of the upper King, flows westerly, receiving the Bridge and Blue Range Creeks on the northern side. When it reaches the parish of Nillahcootie, it takes a sudden turn northward, and passes out through the Barjarg Gap, thence away over the Murray plains, past Benalla, where it divides into two streams. Further south, Ford's Creek rises in the low Springfield hills, east of Mansfield, flows west through Mansfield, and then south across Quartzite ridge to the Delatite. Burnt Creek and Howe's Creek

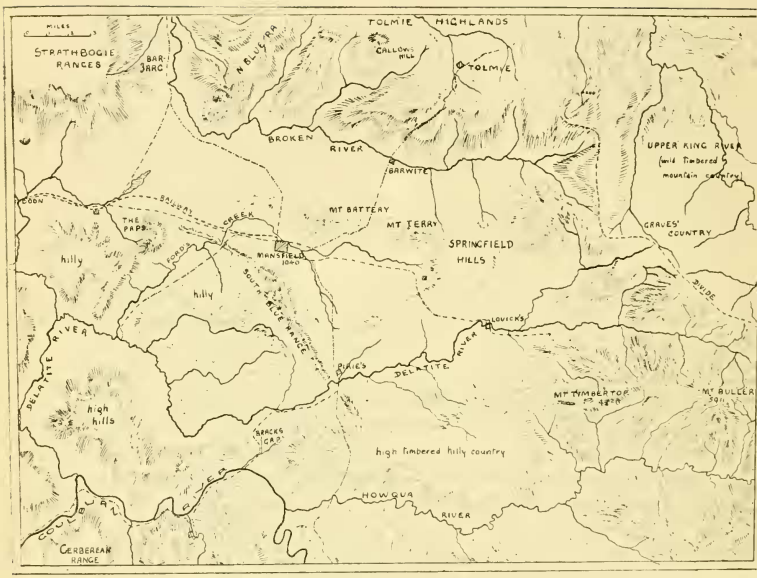

Fig. 1.—Map of the Mansfield district, with approximate relief; the dotted lines indicate main roads.

follow similar, though shorter, courses. The Delatite River rises in the elevated knot of granite and silurian country about Mount Buller, flows westerly, closely approaches the Goulburn at a low wind gap (Brack's Gap), then turns north, and then westerly, to the Brankeet Creek, where the Delatite takes a sharp turn southward, flowing into the Goulburn at the Sugarloaf. The Howqua is somewhat parallel with the Delatite, but rises further east, near Mt. Howitt. It flows west, junctioning with the Goulburn before the latter has taken the westerly turn. South of the latitude of the of the Howqua, the following streams are distinctly northward flowing:—Goulburn, Big, Jerusalem, Rubicon, Acheron, Yea, and King Parrot Creek.

(2)—*Detailed Account.*

(*a*) *Blue Range Creek.*—This pretty stream flows through interesting wooded country in the western part of the Tolmie Highlands. The valley is V-shaped, and has a fairly steep grade. The course

of the stream is almost wholly along the margin of the granitic mass of the North Blue Range. The latter was evidently a residual previous to the deposition of the lower carboniferous mudstones, and the present valley is due to the selective erosion of the softer rock along the junction. (See Fig. 6.)

(*b*) *Bridge Creek.*—This is the other important northern tributary of the Broken River. The valley is in the level-bedded carboniferous mudstones, and in its various gorges and cliffs the influence of the rectangular joint planes of the mudstones is very evident. Of the many surveyed railway routes to Tolmie, one is up this valley, but owing to topographical immaturity, the engineering difficulties prove a stumbling block.

(*c*) *Wild Dog and Back Creeks.*—These lie further to the north-west, and are both picturesque streams flowing through country of granite and indurated slates. Falls 150 feet high are mapped as occurring on both streams. Those on Wild Dog Creek are very fine in winter, and the aneroid under good conditions registered 300 feet from the base to the summit of the falls. Both streams are suggestive of "boat-hook bends," but whether they here bear the significance attached to such bends is not evident.

(*d*) *Broken River.*—Taylor, in his "Physiography of Eastern Australia," says, "An interesting problem awaits the Victorian student at Barjarg on the Broken River." As will be seen from

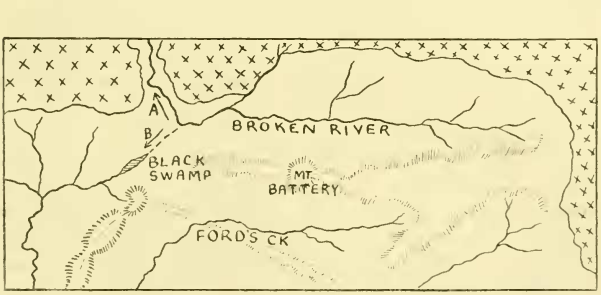

Fig. 2.—Sketch Map of Broken River; A = present course; B = old course.

Fig. 2, the upper Broken and Ford's Creek are parallel streams for a large part of their journey, both flowing in wide valleys in the soft Battery sandstones. As may be noted on any topographic map of the State, the upper Broken is within the natural mountain boundaries of the upper Goulburn. A line of low hills separates

Ford's Creek and the Broken River, and these gradually become lower as we go west. At the point (Fig. 2) where the Broken River

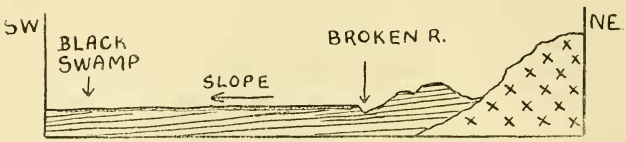

Fig. 3.—Enlarged diagrammatic section along dotted line B in Fig. 2.

takes its sharp northerly turn, there is no divide whatever. (See Fig. 3.) An examination of the area makes it quite evident that the upper Broken River originally flowed south-west through the Black swamp, and on to the Goulburn. There is a gentle slope south-west from the "elbow of capture," and deposits of coarse river pebbles (quartzites, black cherts and porphyry) also occur. These deposits have been opened up for road making, and are quite similar to those of the present Broken River. The capture has been made by a small stream heading back through the Barjarg Gap. The two signs of recent capture, as set out by W. M. Davis,[1] are to be found: (a) a trench (about 90 feet deep in this case) above and below the elbow of capture; (b) the absence of a small tributary at the elbow. The river, on turning north, passes through the Barjarg Gap, a striking valley, which will be considered later.

(*e*) *Ford's Creek.*—This small stream rises in the low Springfield hills, east of Mansfield, flows for some ten miles west across the Battery sandstones, and then turns south-west, cutting across the strike of the silurian to the Delatite. Its interest lies in the fact that, like the upper Delatite, the stream cuts through a very hard ridge of thick quartzite, really a continuation of the South Blue Range. (See Fig. 1.) It would appear to be a "superimposed stream," having had its south-westerly direction prior to the denudation that has left the quartzites standing as a low, but very definite and continuous ridge. The roads to Loyola and Jamieson take advantage of these two gaps.

(*f*) *Delatite River.*—This rises in the highlands about Mount Buller, and is snow-fed for a large part of the year. It flows west, and, while in the region of granites and hardened slates, the valley is steep, rugged, and V-shaped. (See Fig. 4.) Upon entering the level-bedded carboniferous sandstones, the valley is wide and

1 Geographical Essays, p. 602.

Fig. 4.—Showing the nature of the Delatite Valley in (i.) Granites and slates; (ii). Soft level-bedded mudstones; (iii.) Silurian shales.

terraced, showing here the influence of the rock on the "age" of the valley. Crossing Quartzite Ridge the river is again narrowed, and when it fairly enters the folded silurian shales, we have a return to a more V-shaped valley as diagrammed in Fig. 4. Taylor[1] refers to "the extraordinary path followed by the Delatite; it seems to be heading straight for the Strathbogie Ranges, and then flows sharply south to junction with the Goulburn."

(g) Goulburn River.—For the first forty miles the Goulburn flows almost north. After receiving the Howqua, it turns west; it is joined by the Delatite on the north, and the Big River on the south; passes through a narrow valley at the Sugarloaf, thence flowing

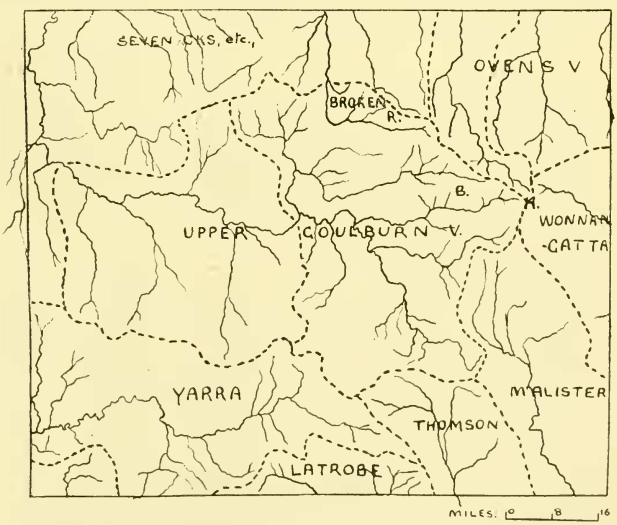

Fig. 5.—Map of the Chief Rivers and Divides (dotted) related to the Upper Goulburn River.

1 Physiography of Eastern Aust., 1911.

westerly to Trawool, where it again turns north to the Murray. It is evident from its varied course (Fig. 5) that it has suffered many changes, since its present valley is far from being the harmoniously branched whole that follows from the uninterrupted development of a large river through a long period of time. (See Fig. 5). As stated, the upper Goulburn has attracted much attention.

Skeats (Records A.A.A.S., Brisbane, 1909), suggests that the divides have been determined by differential denudation, being mainly outlined by plutonic masses. Jutson (Proc. Roy. Soc., Vic., 1911) agrees and believes that the Goulburn has enlarged its territory at the expense of the Yarra and Thompson Rivers. Gregory (Geog. of Vict.) regards the middle Goulburn as a lately developed stream that has captured the King Parrot, Yea and Acheron Rivers from the Yarra valley. Taylor (Physiography Eastern Australia) suggests that the old divide ran from Torbreck to Howitt.

In the absence of reliable topographical maps, and in view of the large area concerned, combined with the rugged and unsettled nature of most of it, it is very difficult to arrive at the truth of the matter. Certainly most maps are misleading, the hachures usually failing to distinguish between comparatively low hills and high resistant mountains. Important ridges are sometimes left out of the maps altogether. In support of the idea that the Goulburn originally flowed north through Barjarg Gap (see Fig. 10), the following considerations may be advanced :—

(i.) Such a course would bring the Goulburn into a harmonious parallelism with other Vict. rivers draining to the Murray.

(ii.) The Barjarg Gap is itself evidence of a highly significant nature.

(iii.) Other gaps such as Brack's Gap (see Fig. 1) also occur, and may mark the old valley.

(iv.) There is a definite north and south mass of highlands which would appear to have been the old western boundary of this valley. These are the Cerberean Range, continued north through the Puzzle Range to the Strathbogies. Through these highlands the only exit westerly is by the narrow valley at the Sugarloaf, west of Darlingford. (See Fig. 5.)

IV.—Mountains and Hills.

1.—*General Description.*

In the northern part of the area (Fig. 1) are the Tolmie highlands. These extend from the Barjarg Gap on the west to the

upper King River on the east, and are in places over 3000 feet in height. Northerly, they slope to the Murray plains, and, on the south, end suddenly in a fairly well defined fault scarp. In the centre of the wide lower carboniferous valley of Mansfield arises Mt. Battery (1760 ft.) and Mt. Terry. This country is all settled, and utilised for dairying and grazing.

Bounding the Mansfield valley, and running N.W.-S.E., is the South Blue Range, with its continuation, the Quartzite Ridge. Further south is the dissected silurian peneplain.

To the East of Mansfield there is a magnificent mountain skyline, including "Graves' Country" (Bainbridge Range), Mt. Buller (5911 ft.), and Mt. Timbertop, or Warrambat (4230 ft.).

2.—*Detailed Accounts.*

(*a*) *Tolmie Highlands.*—This interesting group is apparently a residual tableland of an average height of over 2000 ft. In the south it is in a youthful stage of dissection. In the west, Mt. Samaria and the North Blue Range are of intensely folded and hardened silurian slates, largely intruded by granitic rocks. The

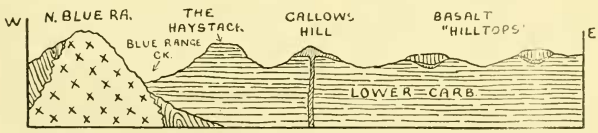

Fig. 6.—Diagrammatic section through the Southern part of Tolmie Highlands.

southern portion is mainly of level-bedded purple Battery mudstones and sandstones. To the north, it is mapped as dacite and porphyry, while conglomerates and sandstones occur again on the East. Volcanic rocks, apparently of both older and newer series, also occur.

The southern boundary of these highlands has been referred to as a fault line. The evidence may be summed up as follows:—

(i.) Slickensided rocks occur, but not abundantly.

(ii.) The ascent from the comparatively low country about Mansgeld to Tolmie is very steep, rising over 1600 ft. in four miles by the best road.

(iii.) The nature of the denudation on the two sides of the Broken River presents an extreme contrast.

North Side.	South Side.
i. Deep V shaped valleys.	Wide, open, level country.
ii. Streams at high grade.	Streams almost at base level.
iii. Cliffs and waterfalls.	
iv. Timbered and thinly populated.	Cleared and well settled.

Added to this is other evidence on the eastern and southern margins of what may be called the Mansfield Senkungsfeld, which will be dealt with further on.

(*b*)—"*The Hilltops*" *and Gallows Hill.*—The chief product of Tolmie is potatoes, grown in the rich volcanic soil of the hilltops. From one such farm, about 3000 ft. above sea level, the owner stated that it cost £2 7s. 6d. per ton to place his potatoes on the Melbourne market, owing to transport difficulties. Although Nature has provided Tolmie with patches of excellent soil, she has given a physiography which is severely against progress. The hilltops of older basalt are similar to those occurring in many other places in Vic. (See Fig. 6.) This leads to the anomaly of cultivated hills and heavily-timbered valleys.

Gallows Hill is the only "hill of accumulation" known in the district. The accompanying diagram (Fig. 6) shows the main features of the southern part of the Tolmie highlands.

(*c*) *Mount Battery.*—This hill (1760 ft.) is an interesting example of the influence of internal structure on external form. The level-bedded rocks give it its flat top and characteristic and numerous ledges and scarp faces. (Fig. 10.)

(*d*) *Mt. Terry and Springfield Hills.*—These are in the lower carboniferous sandstones east from Battery, and present an absolutely different appearance. They have a fairly steep dip westerly, and the difference in the topography thus brought about is striking. (Fig. 7). It appears that the eastern boundary of the Mansfield

Fig. 7.—Section to show structure of Mts. Battery and Terry.

senkungsfeld, instead of rupturing and faulting, has "sagged" down as may be seen looking northward from Ingomar.

(*e*) *South Blue Range.*—Though not high, this range presents a barrier between Mansfield and the country to the south. The gaps utilised for roads are where the Delatite and Ford's Creek cut through the ridge. There is another gap called Monkey Gully, apparently formed by the cutting back of two streams, but this is not much used. The determining feature of this range is a series of quartzite beds usually dipping at a high angle. Massive conglomerates also occur at "The Cliffs" and "The Caves," and three of the highest peaks are due to the presence of plutonic rocks. In its lower parts, the range is composed of a series of hogbacks. It is further interesting, physiographically, as the southern boundary of the Mansfield senkungsfeld. Intense slickensides, with abundant, well-polished surfaces, have been traced for 15 miles along the range.

(*f*) *Cave Hill, etc.*—An interesting knot of hills occurs south of Mansfield in the S. Blue range; the chief points may be noted as follows:—Cave Hill: Largely porphyry, with level Battery sandstone above. Monkey Hill: A centrocline of red sandstone, the beds dripping inwards in all directions at about 45 deg. The Lookout and Porphyry Peak, dominant points in the range, are of quartz-porphyry.

(*g*) *The Paps.*—These twin hills, over 2000 ft. high, rise quite suddenly from the flats to north and east. The rock throughout is quite uniformly of silurian slates. The physiography on the east is less mature than on the west, and with further knowledge of the surrounding physiography these hills will probably be found very significant.

(*h*) *The Darlingford Hills.*—These are of silurian slates, and are typically of the Sugarloaf type; somewhat conical. This is apparently due to the occurrence of more resistant vertical beds, combined with valleys cutting across the strike. The hard beds which have determined the hills may be noted outcropping even from a long distance.

(*i*) *Mt. Buller.*—About 25 miles eastward from Mansfield, one of the most important knots in Victoria culminates in the pinnacle of Mt. Buller (5911 ft.). Although Buller is the highest peak of this knot, Mt. Howitt (5715 ft.) is more important physiographically. (See H in Fig. 5.) To the west and east of Buller occur areas of purple sandstones, these presumably having been denuded away from the intervening area. Their absence is, however, of long standing, dating back prior to the older basalt flows. (Fig. 8.) The older basalt, which occurs on Mount Buller, preserves one of the

highest early tertiary valleys thus formed in Victoria. Similar basalt occurs on Mt. Howitt, but here the underlying rock consists of purple mudstone. The rivers on either side of Mt. Buller at

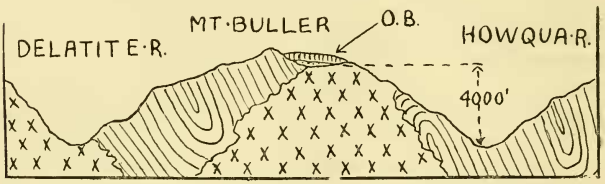

Fig. 8.—Diagrammatic section from North to South through Mt. Buller (6911 feet).

present flow in valleys 4000 feet below the old valley preserved under the Older Basalt. Since the latter rocks occur in conjunction with fossiliferous beds otherwhere in Victoria, the fact may form the basis for some estimation of the amount of erosion in tertiary times. Similar evidence occurs at the Dargo High Plains, Mt. Feathertop, etc.

(*j*) *Mt. Timbertop.*—This mountain, nearer Mansfield and more easily accessible than Buller, has a somewhat complex structure. (Fig. 9.) Its table-top is a long, narrow outlier of level-bedded,

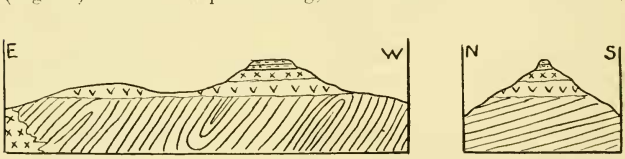

Fig 9.—Diagrammatic sections showing structure of Mt. Timbertop.

coarse sandstones. The summit is 1600 ft. lower than that of Mt. Buller, and since it is of easily weathered material, it will not be long, "as the earth views time," before the sandstones will have disappeared from Timbertop, as they have done further along the ridge, exposing the more resistant underlying volcanics.

V. Other Features.

(*a*) *Barjarg Gap.* (See Fig. 10.).—This outline sketch is sufficient to show that the gap is a very important one. Summers[1]

1 Geology Proposed Nillahcootie Water Conservation Area. Proc. Roy. Society Victoria, 1908.

describes the extremely resistant nature of the rocks at this point. It appears impossible that the small Broken River carved this valley. As has already been mentioned, it is not unlikely this feature once formed the outlet of the northward-flowing Goulburn.

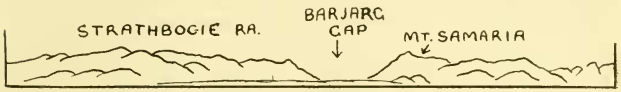

Fig. 10.—Barjarg Gap as seen from the South.

(*b*) "*Power's Lookout.*"—The diagram (Fig. 11) indicates a phase of the physiography of the upper King River. For several miles the coarse, level-bedded conglomerates cap the tableland. The conglomerate is traversed by joint planes, and it is due to the widening of one such crack that we have the rugged scenic effects of "Power's Lookout."

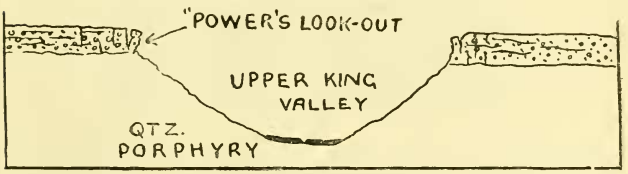

Fig. 11.—Erosion of King's Valley at Power's Lookout.

(*c*) *Junction of Delatite and Goulburn.*—A survey has recently been conducted by the Water Supply Department with a view to constructing a weir at the Sugarloaf, below the junction of the Delatite and Goulburn. By the courtesy of Mr. R. Comer, who was in charge of the survey party, I have been supplied with much valuable information bearing on the probable history of the Goulburn. The survey records show that of the two streams at the junction, the more northerly was originally the stronger stream, which is consistent with Fig. 15. Large deposits of alluvium have been proved to occur here also. The gap through which the river flows is very narrow, and V-shaped, the sides sloping up practically 1 in 1, to well over 1000 feet on either side. The plans also show indications that the Goulburn originally flowed northward through Brack's Gap.

VI.—Progressive Physiography of the Area.

At least three of the great deformative movements that have affected this area have left very definite traces in the folded strata of the various ages. These are shown in Fig. 12. The lowest of the three diagrams represents the intense crumpling and faulting undergone by the upper ordovician, as seen on a small scale in the face of the phosphate mine near Mansfield. Howitt[1] has mapped the strike of these rocks as trending N.W.-S.E. The central diagram is an ideal section through the Loyola hills, where the folding, though steep, is less severe than in the ordovician. The strike is regularly N.W.-S.E. The topmost of the three figures represents a long, low fold in the lower carb., as seen in section on the Broken River at Nillahcootie. The folding in these Battery beds is generally very slight; although there is much deviation, the general dip is, as stated by Dunn,[2] gently S.W. This gives a third N.W.-S.E. strike.

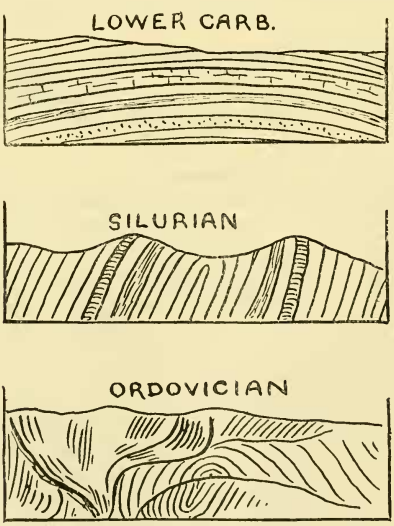

Fig. 12.—Sections showing the comparative folding of strata of different ages.

1 Report on Phosphate of Alumina Beds near Mansfield, Rec. Geo. Sur. Victoria I., 1, 1906.
2 Reports of Mining Registrars. Dec., 1889, p. 69.

It is interesting to note that the post-ord., post-silurian, and post-lower-carboniferous deformations appear, in this area, to have consistently folded the beds with N.W.-S.E. axes.

The general trend of the tertiary crust movements here are more difficult to determine. The reading of the recent physiographic history is greatly retarded by the absence of a reliable contour map. Since physiography is a science of much economic value, it may be fitting here to add another voice to the increasing demand for a Federal Contour Survey.

The upper Goulburn Valley has already been discussed in this paper, and evidence has been adduced toward proving that the present upper Goulburn consists of the headwaters of two original northward-flowing streams. By means of the diagrams (Figs. 13 to 16), endeavour will be made to elaborate this theory. While there is no doubt that differential denudation has played a large part in the formation of this valley, it is very probable that another factor was block-faulting, similar to that proved by Hart for the western part of the Victorian Divide, and similar also to that which has dominated the physiography of the neighbouring area of south-eastern New South Wales. (Taylor.) Jutson has also shown that faulting has played a part in the formation of the adjacent valley of the Yarra.

The inharmonious arrangement of the Goulburn and its tributaries has already been pointed out. The sharp northward bend of the Broken River at Barjarg (Fig. 2) has been noted by many physiographers; old maps of Victoria, indeed, show that certain cartographers had rearranged the mountain chains[1] in order to make this feature look more normal. Further, the discordant nature of the windings of the lower Delatite before entering the Goulburn (Fig. 1) is surely significant of some important crustal movement. We may accept the main divide of Victoria as being a physiographic feature of very long standing, say, back to early tertiary times. Of this physiography we have some remnant in the older basalt cappings of central and eastern Victoria. From such relics, of whose relative heights we have unfortunately little knowledge, it would seem to be an impossibility to reconstruct, even very roughly, those ancient river systems. Especially so, when we consider the disturbed state of eastern Australia in late tertiary times, and the fact that, as shown in Fig. 8, streams such as the Howqua have eroded their valleys over 4000 ft. in very hard rock since the older basalt period.

1 Map of Victoria by J. Bartholomew.

In the following description prominence is given to block-faulting to account for the physiography, and it may be well to sum up the strong evidence in favour of this.

(a) Hart has demonstrated block-faulting in the Western Divide (Grampians, Pyrenees, etc.); these faults run roughly north and south with the blocks tilted upward in the east, and downward in the western part.

(b) Taylor proves that similar features have played a very important part in the physiography of South-eastern New South Wales.

(c) The area under discussion, where closely examined, gives clear evidence of extensive faulting.

(d) Slickensides are abundant here, being traceable for 15 miles along one fault line.

(e) The mapped outline of the granite of the southern Strathbogies is very suggestive. (See Geol. Map of Vict.).

The collecting of stratigraphic data to prove this block-faulting would be, with the present knowledge of the area concerned, practically an impossibility. It can only be said that the physiographic evidence is such as to give rise to the hope that future stratigraphical research here will give a final proof to the theory of block-faulting.

We may assume two huge fault-blocks in the area concerned; one with its high eastern part running north and south in the neighbourhood of Mt. Buller, and dipping westward to the base of the next block, whose uptilted edges are indicated by the Cerberean and Puzzle Ranges.

To the sinking of the eastern block may be perhaps attributed the preservation of the lower carboniferous beds of Mansfield, while the only relic of similar beds on the fault-block to the west may be the small patch of sandstones and mudstones of the Cathedral Range.

Fig. 13 is an endeavour to represent the present upper Goulburn Valley as it would appear if it had quietly developed as a western flowing stream, without the interference of crustal changes during its career. A comparison of this figure with the actual upper Goulburn (Fig. 16) will be interesting.

Fig. 16 shows the two northward flowing streams which have been postulated, the eastern one passing through the Barjarg Gap. Both streams have a tendency to drainage from the eastward, which would be a natural consequence of the tilting of the block. This tendency to receive the chief tributaries from the east is noticeable in many of our present northern streams.

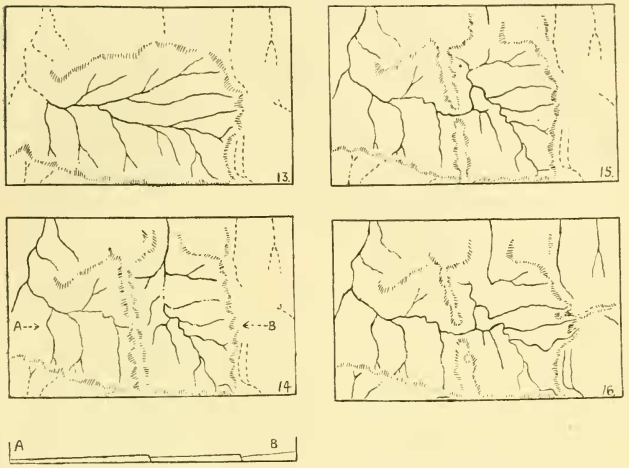

Fig. 13.—The Upper Goulburn as it would have been had it developed uninterruptedly as a western flowing river.

Figs. 14 and 15.—(with Section A B). Reconstruction of the rivers as outlined in the context.

Fig 16.—The Goulburn as it is to-day.

In Fig. 15 it is pictured that, in the progressive movement of the fault blocks, the country has "sagged" along a central E. and W. line. This would cause the river to relinquish its northern valley and dam up against the tilted edge of the next block. Through the least resistant part of this range the river would then cut its way (Fig. 15), and thus take up its journey westward.

Later a northward flowing stream, heading back through the Barjarg Gap, captured the Broken River, and we have the present physiography as outlined in Fig. 16.

It is suggestive and instructive to know that when the goldfields opened at Wood's Point and Jamieson, on the Goulburn, bullock-drivers with their waggon loads of provisions used to make the journey from Benalla, south through the Barjarg Gap, on to the Delatite, across Brack's Gap, and southward up the valley of the Goulburn. This is approximately the course of the stream as indicated in the foregoing paragraphs.

In conclusion, while no problems are solved in this paper, slightly more definiteness has been given to those already known, and a collection of material is presented which may help future workers in the area.

I am greatly indebted to Professor Skeats for his kind visits to me at Mansfield, and for his guidance and suggestions. Thanks are also due to the many residents of Mansfield who helped me to see as much as possible of the district during my stay there. The "Geographical Essays" of Professor W. M. Davis have been a constant source of inspiration.